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# A Model of Skilled Reading Before We Look Inside the Brain of a Reader

A neuroscientist comparing the fMRI brain scan of a first-grade level *beginning* reader to the brain scan of a second-grade level *skilled* reader might see images as different as a tadpole and a frog. In my view, that distinction is one of the great contributions of recent brain scan research. There is no question that beginning reading and skilled reading, like the tadpole and the frog, are the same animal; but when viewed through the lens of a neuroscientist, the immature version looks different. The second-grade skilled reader is like the frog; she has crossed the threshold to maturity and from inside the brain the activation of her reading circuitry probably looks very much like yours. She is able to do grown-up reading.

Brain imagery is providing a new prism for viewing reading and shedding new light on the process. Of special interest to me is a new way of viewing beginning reading; as a two-year metamorphosis between nonreading and skilled or "grown-up" reading, with changes not only observable inside the brain, but also easily recognized outside the brain by classroom teachers. The outside-the-brain changes in beginning readers are as easy to detect by the knowledgeable kindergarten and first grade teacher as are the growth of legs, loss of tails, development of lungs, and ingestion of insects (not plants) in the four phases of tadpole development.

Perhaps the world of the beginning, not yet mature, reader needs supports as different as do the worlds of the tadpole and the frog. Mature and immature readers thrive in and around the classroom just as frogs and tadpoles thrive in and around the pond, but the tadpole eats differently, breathes differently, and survives only in the water. A tadpole's experience is very different from a day in the life of a frog. Perhaps the beginning reader should have

different experiences too, in kindergarten and first grade, to sustain and nourish the changes that must take place between nonreading and skilled reading.

I believe brain scan research, phase theory for word learning, and research for developmental spelling are converging to support such a view. In Chapter 2, we will have a look inside the brain through the lens of a neuroscientist and later, in Chapters 3 and 4, outside the brain through the lens of reading and spelling researchers to gain some new perspectives on what's happening in the life of the beginning reader. But first, let's survey an important model of reading.

## Looking at Reading Through the Lens of Contemporary Psychology

The brain processes information by searching for patterns and processing them within component parts of attention as the mind focuses selectively on a tiny fraction of the stream of information it takes in. The beginning reader may need to rely on some types of information that may not be needed by the skilled reader, just as the tadpole has to rely on a different environment than the frog. If so, it follows that teaching practices for mature versus immature readers may need to be geared to these differences and provide different kinds of support. To better understand the types of information readers must focus on, let's begin with a psychological perspective on reading derived from recent constructivist theories and illustrated in a current model of what many contemporary psychologists believe to be the four important operational components of the reading process: (1) a meaning component inextricably connected with (2) a spelling component, (3) a sound component, and (4) a context of spoken language component. These are the reading-related processes. During reading, attention must be focused on all the processes—meaning, sound, context, and spelling—as the reader is actively engaged in drawing on past experiences in each of these areas and chunking patterns or building new conceptual schemes to construct new sense and new meaning. James Byrnes (2001) in a wonderful chapter on reading in his book, *Minds, Brains, and Learning,* credits the 1989 Seidenberg and McClelland model of reading, made famous and extended by the work of Marilyn Adams (1990), as what many psychologists believe to offer the best psychological perspective on how reading actually works. It's useful for us to review it briefly here because it has had an impact on brain scan research and may have huge implications for our teaching.

The Seidenberg and McClelland model of reading, presented in Figure 1.1, shows what kinds of information the brain is likely to be focusing on during the reading process. The model doesn't attempt to physically show how the brain reads by matching processes with brain activation; rather, it identifies the likely focus of attention and the operations necessary to explain what kind of information the brain of a skilled reader must pay attention to and how this information must be acted upon to make reading possible.

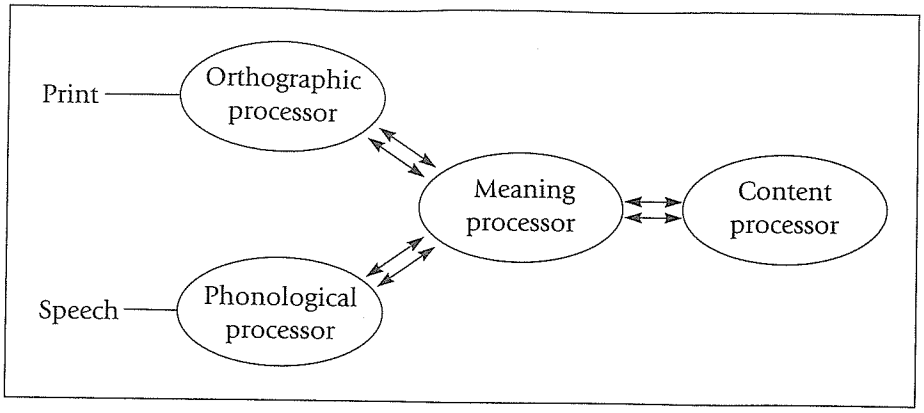


**FIGURE 1.1 The Four Processors of the Reading System (After Seidenberg and McClelland [1989])**

The Seidenberg and McClelland model has four components for mature reading, called *interactive processors*, each processing important kinds of information thought to be necessary for skilled reading—a meaning processor interactively connected to an orthographic (spelling) processor accounting for the role of spelling, a phonological processor explaining the role of sounds in language for reading, and a context processor accounting for important pragmatic, grammatical, and syntactic features of language. Each of the processors detects patterns of regularity or conceptual schemes within the realm of information it reacts to in its area of specialization. All four components work together to drive the reading process. Information flows back and forth between these processors, with especially important connections between each of the components with the meaning processor. One component affects the work of the other allowing for a good bit of redundancy, which in turn provides important backup systems to keep the reading process running smoothly. Arrows in the model between processors indicate how one processor can interact with another to affect the outcome. For example, meaning and syntax might provide information to enable the reader to determine whether the word *lead* when it appears in text is automatically recognized as a noun meaning a heavy malleable metallic chemical element, or a verb meaning to show the way to, or direct the course of, by guiding. This interaction of processors would account for whether the reader would settle on a pronunciation of *lead* that rhymes with *bed* or one that rhymes with *seed*. I find the model very evocative for helping me think about what's happening when I work with children and their reading.

This model has influenced some of the brain researchers too. For example, some processors are believed, in the words of Byrnes, "to contain a large quantity of interconnected 'units' that are thought to bear a close correspondence to

neural assemblies" (2001, 116). Just as we have seeing and hearing circuits, readers likely have systems of interacting modes for orthographic, phonological, syntactic, and semantic aspects of language. Some of these are piggybacked instinctive circuitry already in place for spoken language. Some must be activated specifically for the acquired ability of reading. Later, when we look at the brain scan research, we'll see how some of the neuroscientists who think they have identified the underlying neural mechanisms for reading in the brain believe the neural assemblies actually do their work. The work presented in this book doesn't depend on the Seidenberg and McClelland model, but the model corroborates this work and is certainly compatible with it.

The Seidenberg and McClelland model helps us understand some of the core mechanisms of reading and provides some broad sense of how skilled reading might work. Importantly, it helps us better understand key contributions from the brain imagery and perhaps see research findings in a new light that has extraordinary importance for our teaching. Among the findings that will be highlighted in the chapters to follow are these propositions:

1. Spelling knowledge is much more important for reading than has been acknowledged.
2. Beginning readers differ from skilled readers. We may need a separate model (or blueprint) for beginning reading.
3. Reading teachers must guide beginning readers to make the chunking breakthrough. Chunking spelling patterns and automatic word recognition are necessary to skilled reading. Without ability to recognize words automatically, the reader cannot advance to a skilled, mature level.
4. The brain learns to do things automatically by firing neurons over and over. Certain kinds of repetition are hugely beneficial for readers because repetition leads to automaticity.
5. At various stages in development, some component operations of the reading process are more important than others. The processes needed for beginning reading may become automatic in skilled readers. Our teaching will improve if we focus on the right operational components at the right time.

Before looking at the brain scan research, let's flesh out each of these propositions in a bit more detail.

**1. *Spelling Knowledge Is Much More Important for Reading Than Has Been Acknowledged.*** Notice the prominence of spelling in the model. All the other processors are aspects of spoken language. To some extent, they develop naturally and are already in place when children begin to read. The orthographic processor is the only part of the model that must be acquired uniquely for reading. Spelling, how the child thinks letters or combinations of letters represent meaningful words, may be much more important than it has been regarded in the

past. The brain of a very literate person has some mechanism for storing and retrieving the exact *spelling* of a word. At the same time a reader sees a known word in print or a writer thinks of a known word to write down on paper, assemblages of neurons in the brain of a highly literate person fire in sync, not only with the word's meaning and pronunciation, but with its correct spelling. (This happens in the region designated as Area C in Figure 2.1 on page 15.) The brain of a literate person has an enormous capacity to sort through the thousands of letter combinations on a page of print and find the regular patterns within it by chunking. *Spelling, in fact, is a chunking skill. The reader/writer/speller must learn to chunk strings of letters into discernable patterns.* Look at the following string of letters:

maercecidnaseikoocklim

Twenty-two bits of information are provided in this letter string. Study the sequence for about ten seconds and then look away and try to recall the sequence.

The limitations of working memory make this a difficult task. It's virtually impossible to remember the letters unless one notices chunks of spelling patterns such as maerce-cid-nase-i-koock-lim, a chunking process, which makes it possible for one to remember them. Now for the next ten seconds, look at the same twenty-two bits of information again. This time they are presented in reverse order.

milkcookiesandicecream

Do you now have an easier time remembering this sequence? Did your brain detect the spelling patterns first? Did you add sound, context, and meaning in processing the twenty-two letters in the string in the second example?

Spelling plays such a prominent role in the Seidenberg and McCelland model and, as we shall see, in the brain scan research that one might wonder why it plays such a minor role in most of our literacy programs. In most elementary schools spelling is a "supplementary" subject, an afterthought, yet it is a key component of this highly acclaimed model of skilled reading with implications for reading speed and fluency, and the only component uniquely specific to reading.

Developmental spelling plays a huge role in beginning reading, and tracking its development may be one of the most powerful ways to assess how well beginners are developing as readers (Snow et al. 1998; Gentry 2004). Tracking developmental spelling is at the core of good assessment-driven instruction for beginning reading. Chapters 3 and 4 illustrate how the beginning phases of reading and writing unfold in the same phases as developmental spelling, which are as easy to see in invented spelling as the four phases of the tadpole's metamorphosis into a frog.

2. ***Beginning Reading and Skilled Reading Are Not the Same.*** Seidenberg and McClelland propose a model of skilled reading, and much of the research and

understanding of reading that has come out of this model has focused on differences between *poor* and *skilled* reading. We also need to look at differences between *beginning* and *skilled* readers. If beginning reading and skilled reading are different, it invites one to create a separate model (or blueprint) for beginning reading. Would a model for beginning reading account for phases like the ones we see in tadpole development? Would it predict a need for a focus on moving children to rapid and automatic recognition of spelling patterns in words and subword units, since automatic recognition of spelling patterns appears to be the sine qua non of skilled reading? Would it help teachers of beginning reading to recognize the need for each child to make the chunking breakthrough for decoding? What is the role of repetition for fluency in beginning reading?

3. ***A Necessity of Skilled Reading Is Automatic Word Recognition.*** Think of a three-syllable word beginning with an *r* that means a boat race. Can you spell it? If the word has popped in your mind, a unique constellation of neurons have fired triggering its meaning, its sound, and its spelling. (Four out of five of you can see the word's spelling in your mind, but one in five cannot see it. If you are in the group of one-in-five struggling spellers, you may be puzzling over *ragatta, regatta, regata, regotta,* or *rigatta.*) Your automatic word processor is at work. You are calling on the word module in your brain for *regatta.* If you know this word, your automatic processor enables you to read *regatta* instantly. (Some of you who are in the struggling-spellers group may use different circuitry to activate words.)

If the defining feature of skilled reading is automatic word recognition—and I believe it is—a major focus of beginning reading may be to get the child to a point that word recognition *is* automatic. After automatic recognition is accomplished, it's much easier for attention to be focused on higher levels of processing like sentence integration and, ultimately, comprehension and meaningful connections. A primary concern for beginning reading, therefore, may be how to teach automatic word recognition and automatic recognition of common spelling patterns—that is, to get beginning readers to make the chunking breakthrough. In my opinion, much progress has been made in the classroom with techniques such as using word walls in first grade, a technique that connects with brain research because good word wall work is multimodal, invoking multiple assemblages of visual circuitry, auditory circuitry, kinesthetic circuitry, and tactile brain circuitry working together along with lots of repetition to get words into an automatic processor. There are additional techniques to accomplish the critical role of automatic word recognition with particular emphasis on learning how spelling works, analogizing, and rapid recognition of chunks of phonics patterns.

4. ***The Brain Learns to Do Things Automatically by Firing Neurons Over and Over.*** In this book I highlight the role of appropriate repetition in our teaching, especially at beginning levels. Recognizing the role of repetition is nothing

new. Much has been written recently about the benefits of increasing the volume of reading because higher reading volume gives all four component operations—using context, using spelling, making meaning, and using phonology—a healthy workout, and the residual benefit is that reading skills such as sight-word recognition, vocabulary development, reading fluency, and conceptual development grow exponentially as a result of lots of independent reading practice (Allington 2001). This is readily apparent in studies such as the one by Cunningham and Stanovich (1998), which found that readers who scored at the 10th percentile on reading tests read about 8,000 words per year contrasted with 282,000 words per year by readers who scored at the 50th percentile *and 1.8 million words per year by readers who scored at the 90th percentile.* The difference in the numbers of firing synapses for word recognition by readers at these various levels is staggering.

Remarkably, Marie Clay addressed the importance of repetition for building strong readers as well as the benefits of making reading stronger by practicing it, and she addressed it very specifically over twenty years ago in *Observing Young Readers.* Her brilliant observations sound much like she is making direct reference to current knowledge of how the brain works even through she wrote the following passage long before the Seidenberg and McClelland model or the possibility of brain scan imagery:

> A kind of learning occurs in natural language tasks [*such as reading and writing*], which is rarely thought about. Proceeding by rough and ready theories but operating self-correction processes the child practices old learning [*recognizing known words, for example*], giving a minimum attention, while new learning is laboriously worked over until it has found a place in the system [*like moving from an area of slow and analytical word analysis to an area where the brain specializes in recognizing words automatically*]. Every time a child reads a sentence or writes a story each letter sequence and language form in that sentence is, by its use, moving from somewhere in the novel language dimension towards being used with minimum attention. [*This is an excellent description of how some neuroscientists theorize the brain learns to read [and write] words instantly.*] The hard-to-spell new word seems to be the one which requires processing [*in the brain*] but every other word in the sentence profits [*in the brain*] by being used, moving further towards fluency, "automatic responding" and flexibility of use. High frequency words move most rapidly to this state. So when we record a series of "correct" responses for the child reader [*the brain is actively reinforcing itself—reinforcing the neural pathways for each specific word module, for example—and building automaticity*] we are not really noticing this continuing process of learning and overlearning. [*Note that today's psychologists include terms such as "redundancy" or "a backup system," which mesh well with the concept of "overlearning."*] (Clay 1982, 4) [Emphasis and parenthetical material added]

5. *At Various Stages of Development, Some Component Operations of the Reading Process Are More Important Than Others.* While all four operations—context, spelling, meanings, and phonology—work in concert to help the reader construct meaning from print, at various stages in development, some of these component operations may be more important for reading, with others backing them up. Here's an example: the Seidenberg and McClelland model accounts for the importance of both context clues and spelling clues, but which is *more* important? And when? In recent years many beginning reading programs placed context and meaning front and center—with only tiny emphasis on spelling and phonics. According to Byrnes (2001), the Seidenberg and McClelland model of reading calls that into question when considering poor versus skilled readers. One might wonder whether the same holds true for beginning versus mature readers:

> But research has shown that the context-meaning effects [*i.e., context clues*] are weak relative to the orthography-meaning effects [*i.e., spelling clues*]. That is, readers are much better at predicting possible meanings of a word based on its perceived spelling than they are at predicting which word will follow a preceding context (Adams 1990). When context-meaning links conflict with orthography-meaning links, the latter win out. Thus, skilled reading consists, first and foremost, of learning the correspondences between written words and their meanings [*i.e., spellings*]. Context effects occur after words are perceived and various possible meanings are accessed. (122) [Emphasis and parenthetical material added]

So while context, spelling knowledge, meaning, and knowledge about the sound system of language are all important for reading, spelling knowledge may come first and be more critical to the reading process at certain phases of development with the other systems backing it up. After all, the beginning reader already has brain circuitry for connecting sound and context to meaning due to his or her innate ability to speak language. The four-year-old who speaks English already uses the forty-four sounds of English to speak, though she may not be able to consciously manipulate them, and she is able to fill in the blanks if you say, "Turn on the ————," or "Let's ———— to the mall." By contrast, most four-year-olds have no knowledge of how spelling works—even if they have memorized how to write their names. There is no systematic letter–sound processing. The child has simply memorized an arbitrary set of squiggly marks. A good teacher of beginning reading must teach how the squiggly marks represent sounds and words.

Here's an example of how spelling cues may be more important than context clues. Remember the struggling second grader whom I wrote about in the introduction who read *foot* and *feet* indiscriminately? I observed her relying too heavily on context clues time and again, reading *prince* as *king*, for example, in a story about Cinderella when clearly the spelling p-r-i-n-c-e should not fire off

neurons for *king*. Her overreliance on context clues, which signaled the need for a word to be a male member of the royal family, trumped the more important spelling cues. This underreliance on spelling cues persisted; even after she first began to recognize patterns like *hop, stop,* and *pot,* she still might substitute *cop* for *police.* Her tutor chose to focus on context clues in spite of the fact that she overrelied on context and underrelied on spelling patterns as in reading *po-lice* (*police*) as *cop*. The tutor chose the wrong instruction to mediate the problem.

In the chapters that follow, we will fine-tune your ability to choose the right teaching technique at the right time. You'll learn how what children are doing or not doing with spelling is a clue to what techniques you may use to help them advance as readers. You'll learn which of four phases a beginning reader is in at a particular point in time and specific instructional techniques to lead them into the next phase. You'll learn what kind of repetition is beneficial for readers in a particular phase to stabilize and establish word learning until word recognition becomes automatic. You'll learn how to tell when the child is falling behind the expected level of development and how you can provide early intervention to fix the problem.